

Having thus described the preferred embodiment, the invention is now claimed to be:

1. A method for determining a mass flux of an entrained phase in a planar two-phase flow, the method comprising the steps:
  - recording images of particles in the two-phase flow;
  - determining respective sizes of the particles as a function of a separation between spots identified on the particle images;
  - determining respective velocities of the particles; and
  - determining the mass flux of the entrained phase as a function of the size and velocity of the particles.
- 5 2. The method for determining a mass flux of a particle as set forth in claim 1, wherein the recording step includes:
  - recording an image of a transparent particle.
3. The method for determining a mass flux of a particle as set forth in claim 1, further including:
  - identifying glare spots on the particle, the particle size being determined as a function of a separation between the glare spots.
4. The method for determining a mass flux of a particle as set forth in claim 1, wherein the step of determining the velocity includes:
  - determining the velocity as a function of a velocimetry of the particles within the images.
5. The method for determining a mass flux of a particle as set forth in claim 4, wherein the step of determining the velocity as a function of the velocimetry includes:

- 5 obtaining two exposures of the respective glare spots of the particles entrained in the fluid; and  
measuring a displacement between the two exposures during a specified time interval.

6. The method for determining a mass flux of a particle as set forth in claim 4, wherein the step of determining the velocity as a function of the velocimetry includes:

detecting a Doppler shift of light.

7. An optical flow meter for determining a mass flux of a particle, comprising:  
a camera for recording an image of the particle entrained in a two-phase flow; and

- 5 a processor for determining a size of the particle as a function of a separation between spots identified on the particle, determining a velocity of the particle, and determining the mass flux of the particle as a function of the size and velocity.

8. The optical flow meter for determining a mass flux of a particle as set forth in claim 7, wherein the spots are glare spots.

9. The optical flow meter for determining a mass flux of a particle as set forth in claim 8, wherein the separation between the glare spots is determined as:

$$x_o = -aM \cos \frac{\theta_o}{2};$$

$$x_i = n a M \sin \frac{\theta_o}{2} \left[ n^2 + 1 - 2n \cos \frac{\theta_o}{2} \right]^{\frac{1}{2}}; \text{ and}$$

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$$d_p = \frac{2 \Delta \varepsilon_p}{\left| -M \cos \frac{\theta_0}{2} \right| + \frac{n M \sin \frac{\theta_0}{2}}{\sqrt{n^2 + 1 - 2n \cos \frac{\theta_0}{2}}}},$$

where  $d_p$  is an estimate of the particle diameter,  $n$  is a ratio of an index of refraction of a material of the particle to an index of refraction of a medium,  $a$  is a radius of the particle,  $M$  is an optical system magnification,  $\Delta$  is a number of pixels separating the glare spots on a surface of a CCD,  $\varepsilon_p$  is a size of the pixels in the CCD, and  $\theta_0$  is an observation angle.

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10. The optical flow meter for determining a mass flux of a particle as set forth in claim 8, wherein a Gaussian peak location estimate is used for determining a location of respective peaks of the glare spots, the separation between the glare spots being determined as a function of the locations of the peaks.

11. The optical flow meter for determining a mass flux of a particle as set forth in claim 7, wherein the camera is a CCD camera.

12. The optical flow meter for determining a mass flux of a particle as set forth in claim 7, wherein the particles are transparent.

13. A method for determining a size of a particle, the method comprising:

receiving an image of the particle entrained in a two-phase flow into a processor;

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reducing background noise within the image;

grouping the pixels having non-zero values into respective particle image arrays;

identifying glare spots within the image as a function of the particle  
image arrays; and  
10 determining the size of the particle as a function of a separation  
between the glare spots.

14. The method for determining a size and a velocity of a particle as  
set forth in claim 13, wherein the reducing step includes:  
limiting non-zero intensity values of pixels within the image.

15. The method for determining a size and a velocity of a particle as  
set forth in claim 14, wherein the limiting step includes:  
determining a global threshold intensity value for the pixels within the  
image; and  
5 setting intensity values of pixels below the global threshold to zero.

16. The method for determining a size and a velocity of a particle as  
set forth in claim 15, further including:  
determining a local threshold for discriminating the particle within the  
image.

17. The method for determining a size and a velocity of a particle as  
set forth in claim 13, wherein the grouping step includes:  
scanning the image for the pixels having the non-zero values;  
identifying one of the pixels as having the non-zero value;  
5 identifying pixels adjacent to the pixel having the non-zero value;  
grouping any of the adjacent pixels having the non-zero values into the  
particle image array;

identifying subsequent pixels adjacent to each of the adjacent pixels having the non-zero value; and

10                   grouping any of the subsequent pixels into the particle image array.

18.     The method for determining a size and a velocity of a particle as set forth in claim 13, further including:

          rejecting ones of the particle image arrays that are saturated.